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(54) Illuminant head assembly for a photographic film image scanner

(57) An illuminant head assembly for a photographic film image scanner includes a linear light source, preferably a linear array of spectrally distinct illuminant elements combined with a main body having an elongate light conducting channel aligned with the light source and having a light pipe in the light conducting channel, the light pipe having a light diffusion material dispersed therein. The illuminant head assembly in a preferred embodiment includes additional light sources at one or both ends of the linear array and the main body includes additional light channels aligned with the additional light sources, the additional light sources and channels serving as illuminant sources for scanning marginal regions of the photographic film in the film scanner.

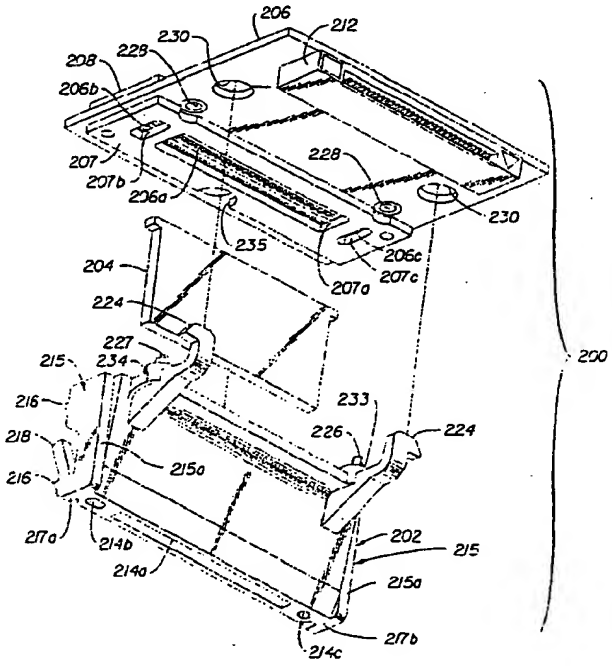

FIG. 6

Description

[0001] The present invention relates generally to the field of photographic media image scanners. More specifically, the invention relates to small, low cost scanners adapted for use with personal computers by consumers who wish to generate digital images from processed film stored in a film cartridge as in the case of the Advanced Photo System (APS) film.

[0002] Users of personal home computers are increasingly loading digital image files into their computer for viewing, communicating images through the Internet and printing hardcopies on personal color printers. With the introduction of the Advanced Photo System, which stores processed film in the film cartridge, there is a growing interest in being able to scan and digitize images from the stored film for use on the personal computer. Such a scanner should not only be low cost, to obtain broad acceptance as a consumer product, but also needs to be compact in size to be able to fit into a standard disk drive bay on a personal computer.

[0003] In designing a film scanner for this type of application, it is important to have a design that uses a minimum of parts, is simple to manufacture and yet creates and maintains critical, micro-precision alignment of the photosensor with the film plane in the scan gate. The design of the present invention fully meets these objectives.

[0004] In accordance with one aspect of the invention therefore, there is provided an illuminant head assembly for a photographic media image scanner which comprises a linear light source and a main body having a first elongate planar light conducting channel aligned with the linear light source, wherein the light conducting channel includes a planar light pipe therein, the light pipe having a light diffusion material dispersed throughout the light pipe.

[0005] In accordance with another aspect of the invention, an illuminant head assembly is provided for a film scanner of the type having a scan gate and a pair of support arms on opposite sides of the scan gate, at least one of the support arms having a notch formed therein. In this aspect of the invention, the head assembly comprises a linear light source and a main body having a first elongate planar light conducting channel aligned with the linear light source, the light conducting channel including a planar light pipe therein, the light pipe having a light diffusion material dispersed throughout the light pipe. The main body has opposite side portions adapted to mate with the support arms of the film scanner. At least one of the side portions has a spring finger positioned to mate and lock into the notch in the support arms when the illuminant assembly is mounted into position on the support arms.

[0006] These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings. In the drawings:

FIG. 1 is an isometric view showing a film scanner embodying the present invention;
FIG. 2 is a perspective view of a film scanner chassis embodying the present invention;
FIG. 3 is a partially exploded perspective view of an imaging apparatus and illumination head embodying principles of the present invention;
FIG. 4 is a cross section side elevation view of the imaging apparatus and illumination head of FIG. 3;
FIG. 5 is an exploded perspective view from above of the illumination head shown in FIGS. 3 and 4; and
FIG. 6 is an exploded perspective view from below of the illumination head shown in FIGS. 3 and 4.

[0007] In FIG. 1, there is shown a compact film scanner 10 adapted for use with APS film cartridges to convert film images to digital images. The illustrated scanner comprises an outer casing 12 and a front bezel 14 which enclose an internal film drive chassis to be described in more detail below. The chassis is provided with an APS film cartridge chamber 16 for receiving a manually inserted APS film cartridge. A hinged, spring-loaded door 18 includes a locating device 20 which acts to engage the end of the inserted film cartridge (not shown) as the door is closed to aid in properly positioning the film cartridge in the chamber 16. A latch hook 22 on the door engages an internal latching mechanism 24 to lock the door in the closed position. When it is desired to remove the film cartridge, a door release button 26 is actuated to unlock the latch mechanism allowing the door to spring open. An internal spring loaded mechanism (not shown) within the cartridge chamber forces the cartridge partially outward, allowing the user to grasp and remove the cartridge.

[0008] Referring to FIG 2, a general description of the internal film drive chassis 30 of the scanner 10 is presented here. The illustrated chassis comprises a lower frame 32 and an upper plate 34 which, when assembled as shown, define the film cartridge chamber 16, a film takeup chamber 36 and a film path 38 longitudinally extending between the two chambers. A film drive roller mechanism 40, including nip roller sets 52 and 53, is located near the film cartridge chamber 16. A pair of elongated apertures 41a, 41b are provided in upper plate 34 to allow access by magnetic read/write heads (not shown) to magnetic data tracks on the magnetic recording layer formed on the APS film as the film is driven along the film path, thereby enabling data transfer to and from the film magnetic layer, in known manner, as part of the film scanning process. Lower frame 32 is provided with depending skirt walls 39 that form a cavity in which is mounted imaging apparatus 50.

[0009] One end of the imaging apparatus 50, as will be seen in reference to FIG. 3, comprises a film scanner

end which is snap mounted into a film scanner opening 51 formed in the chassis 30. The film scanner end is straddled by film drive nip roller sets 52 and 53. The nip rollers are driven by a film drive stepper motor (not shown) which is directly coupled via drive gear 54 to main drive rollers beneath idler rollers 60 and, via main drive pulley 56, elastic drive belt 57 and slave drive pulley 58 to slave rollers beneath idler rollers 60'. Idler rollers 60 and 60' are held in place against their respect drive rollers by means of retention clamps 61 held under pressure by tension springs 62. The film scanner end of imaging apparatus 50 includes a pair of upstanding support arms 120 integrally formed on the imaging apparatus 50. The arms 120 comprise support mounts for an illuminant head assembly 200 (FIG. 3) constructed in accordance with the present invention as will be described more fully later. The other end of the imaging apparatus 50 comprises a sub-housing 64 which encloses a linear CCD photosensor device 66 (FIG. 3). The CCD is electrically mounted on a printed circuit board 63 but is physically supported directly from the sub-housing 64. The elongated housing of imaging apparatus 50 comprises the sole means of support of the CCD from the chassis frame 32. Spaced apart film guide pins 65a and 65b are located along one edge of the film path 38 to aid in accurately aligning magnet recording tracks on the APS film with the magnetic read/write heads positioned in the apertures 41a, 41b. The lower frame 32, upper plate 34 and housing body 72 are molded in the desired configurations out of a suitable, preferably blackened, 30% glass filled polycarbonate material held together by suitable fastening means (not shown), such as screws, snaps, adhesives and the like. The use of this material is highly beneficial in this application because of its stability in the presence of humidity and temperature changes which is particularly important in this configuration wherein the photosensor relies on the housing as the sole means of support from the scanning film plane.

[0010] Referring jointly to FIGS. 3, 3a and 4, details of the imaging apparatus 50 will be described. Imaging apparatus 50 comprises a hollow, two-piece molded housing 70 having an upper, main body portion 72 and a separable, lower body portion 74. One end 80 of the housing 70 comprises a film scanning portion and the other end 82 comprises a light sensor portion. The film scanning end 80 includes an elongated light entry slot 83. As best seen in FIG. 3a, a pair of film rails 84 are integrally molded onto the end of the imaging apparatus so as to bridge the slot 83 longitudinally in the direction of film path 38 to thereby define a film plane 86. For this purpose, the film rails 84 are spaced apart only slightly more than the lateral dimension of the negative image on the film strip so as to define a first scanning aperture 83a coincident with images on the film. The portions 83b and 83c extending beyond the rails 84 define secondary scan apertures, each of which is coincident with a respective edge region of the film. The other end 82 of the housing 70 includes sub-housing 64 which encloses linear CCD 66 mounted on printed wiring board 63. CCD 66 is supported from sub-housing 64 by means of radiation, preferably UV, curable adhesive "rivets" (not shown). Notch 89, and a similar notch on the far side of sub-housing 64, allow access by the UV radiation to the adhesive material inside the sub-housing 64 during the curing step.

[0011] The upper body portion 72 of the housing 70 is formed at right angles between the scanning end 80 and the photosensor end 82 to provide a compact structure enabling mounting of the film scanner 10 in a drive bay of a personal computer. To this end, a mirror 90 is mounted internally against ridges 91 formed inside the upper housing body 72 at a 45° angle to serve as reference datum surfaces for mounting of the mirror 90. The mirror is held in place against the ridges 91 by means of compressive spring fingers 92 formed on the housing lower body portion 74. Internally of housing body portions 72 and 74, about half way between mirror 90 and CCD 66, a focusing lens assembly 76 is mounted in axial alignment with the light path from the scanning end 80 via the mirror 90 to the photosensor end 82. The focusing lens assembly 76 includes a focusing lens set 77 positioned within a cylindrical lens mount 78. The lens mount 78 is provided with a circumferential groove 79 for use in setting the focus position of the lens 76 during assembly and alignment of the imaging apparatus. To this end, the housing upper body portion 72 is provided with an adjustment slot 79a extending longitudinally of the housing 70. During the assembly process, a probe can be inserted through the slot 79a into engagement with groove 79 to move the lens mount 78 axially to focus the film plane 86 onto the CCD sensor 66. Flexible spring fingers with pressure pads 105 are molded into the lower body portion 74 to temporarily hold the lens mount 78 in place after the upper and lower body portions are assembled together until focusing alignment is completed, at which time the lens is permanently retained by adhesive injected through either one or both of the space bridging the spring fingers with the lens mount 78 and the lens adjustment slot 79a in the upper body portion 72, preferably the latter. Upper and lower body portions 72 and 74, when assembled together as shown, are held together by U-shaped spring clamp arms 106 on lower body portion 74 snapped over retention tabs 107 formed on upper body portion 72.

[0012] Integrally formed on the outer lateral sides of the scanning end 80 of the housing 70 are a pair of support arms 120 that serve the dual functions of supporting the housing 70 on the chassis lower frame 32 and rigidly supporting a illuminant head assembly 200 in precise position over the light entry slot 83. The support arms are preferably integrally molded on the upper body 72 and are mirror images of each other. The lower portion of the support arm 120 includes a recessed portion 121 at the bottom of which there is provided a ramp 122

leading to the lower retention edge 124. The upper portions of each of the support arms 120 are provided with a channel 132 and notches 134, the purpose of which is explained below. The chassis lower frame 32 includes a pair of integrally molded, downwardly extending retention hook arms that are springlike and flex outwardly to permit insertion of the scanning end 80 of the illumination housing 70 onto the chassis lower frame 32. During assembly of the imaging apparatus 50 to the lower chassis frame 32, the chassis frame 32 is turned upside-down and the scanning end 80 is inserted into the opening 51. During this snap-in step, the hooks at the end of the retention arms initially fall into the recessed portions 121 and eventually engage the ramps 122 at which point the retention arms are flexed outwardly until the retention hooks grab and hold the housing assembly by engagement with the retention edges 124. The scanning end of the housing is now rigidly and securely captured between the retention arms. Once this is completed, the lower frame 32 can be turned right side up for addition of the drive roller sets 52 and 53 and the upper chassis plate 34. As can best be seen in FIG. 2, the upper portions of the support arms extend above the chassis 30. As will be seen, this allows insertion of an illuminant head assembly 200 into the channels 132 of the support arms.

[0013] Referring jointly to FIGS. 3-6, the illuminant head assembly 200 of the present invention will now be described. The illuminant head assembly 200 comprises a main body 202, a planar light pipe 204, a printed circuit board 206 on which are mounted a linear array of red, green and blue LEDs 206a and additional LEDs 206b and 206c positioned at opposite ends of the linear array 206a. The linear array provides spectral red, green and blue illuminant for scanning of image areas on the film. The additional LEDs serve as respective sources of light for reading of bar code data (LED 206b) and for sensing of reference perforations in the film (LED 206c). Preferably, LED 206b emits in the red spectrum. However, since Dmin density of the film is almost transparent in the red spectrum, LED 206c is selected to emit in another color spectrum such as green or blue. A heat sink panel 208 is mounted on the opposite side of the circuit board from the LEDs 206a-206c. An apertured panel 207 is mounted over the LEDs on the circuit board and is provided with an elongated aperture 207a aligned with the linear LED array 206a and two smaller apertures 207b and 207c aligned with LEDs 206b and 206c, respectively. Panel 207 serves as a dam to retain a clear silicone sealant disposed in each of the apertures 207a-207c. The circuit board 206 also carries a connector 212 providing power connections to the LEDs from a microcontroller (not shown).

[0014] The main body 202, made of a suitable highly reflective, white polycarbonate material, is provided with an elongated, planar light channel 214a into which light pipe 204 is inserted. Light pipe 204 is preferably made from a clear polymethylmethacrylate material loaded with a diffusion material such as barium sulfate at loadings of 0.1% to 1.0% by weight and preferably 0.25% by weight. The particle size of the barium sulfate ranges between 5-20 microns. The balancing of the interaction of the length of the light pipe, the loading of barium sulfate and the particle size of the barium sulfate allow for a diffuse light output at the bottom outlet of the elongated light channel 214a without the need for any special surface finish on the light pipe or the addition of a separate diffusion component. Thus the barium sulfate loaded light pipe 204 serves as the sole light diffusing agent for exposure of the LED light sources to the film being scanned. Smaller side channels 214b and 214c, which do not have light pipes therein, serve to convey the illumination from LEDs 206b and 206c, respectively, to the bar coded data and reference perforations along the longitudinal edges of the film. The sides 215 of the main body 202 are shaped to fit into the channels 132 of the previously described support arms 120. Pointed crush ribs 216, which engage the edges 132a of the channels 132, ensure a tight fit of the body sides 215 in the channels as well as align edge surfaces 215a to edge surfaces 132c of the channels 132. By dimensioning and controlling, during manufacture, the position of surface 215a to the elongate light channel 214a, the alignment of the elongate light channel 214a to the elongate light entry slot 83 is maintained without subsequent adjustment.

[0015] Sides 215 of the main body are also provided with locking tabs 218 which engage notches 134 in the support arms to rigidly lock the head assembly into the support arm structure. The locking tabs 218 are integrally molded as part of the main body. The length width and depth of the locking tabs are such that, during assembly, the tabs deflect to allow insertion then spring back into position and contact the notches 134 preventing any movement up and out of the channels 134. This action maintains alignment of surfaces 217a and 217b (FIG. 6) to surfaces 132b at the bottom of the channels 132. The parts of the head assembly are easily snapped together by slipping end 220 of the printed wiring board under a capture hook 222 formed on the main body 202 and rotating the printed wiring board down until the under surface of the printed wiring board rests on the upper surfaces of support pads 232, 233 and 234. Aperture panel 207 is provided with a semicircular shaped notch 235 which mates with the semicircular shaped support pad 232. Support pad 232 and notch 235 serve to initial locating means for assembly of the light sources to the main body. Support pad 233 is provided with a diamond shaped locating pin 226 and support pad 234 is provided with a circular locating pin 227. Each of the pins mate with corresponding locating holes 228 on the circuit board. As such, both pins serve to set the alignment of the LEDs 206a, 206b and 206c to the elongate light channels 214a, 214b and 214c during assembly. When the board is fully rotated into position on the support pads, snap locking hooks 224 on the

main body gage mating locking holes 230 in the printed wiring board to securely hold the board in place on the main body. The arrangement described is a simple, practical self-aligning mounting arrangement for attaching the head assembly 200 in a secure and rigid manner to the imaging apparatus 50.

[0016] It will be appreciated from the foregoing description that what has been described is an illuminant head assembly of simple and compact design that is provided with snap lock features that facilitate rapid assembly and that precisely and rigidly positions the LED light elements in place over the scanning aperture 83 of the imaging aperture without the requirement for additional fasteners. The use of an elongated light pipe with diffusion material in the light pipe simplifies the cost and complexity of the head design by eliminating the need for a separate diffusion element at the outlet of elongated channel 214. Additionally, the incorporation of spectrally discrete, for example, red, green and blue, separate illumination elements enables independent adjustment of the spectral components of the film scanning illumination.

Claims

1. An illuminant head assembly 200 for a photographic media image scanner 10 characterized by:

   a linear light source 206a; and
   a main body 202 having a first elongate planar light conducting channel 214a aligned with the linear light source, the light conducting channel including a planar light pipe 204 therein, the light pipe having a light diffusion material dispersed throughout the light pipe as a sole light diffusing agent.

2. The illuminant head assembly of claim 1 wherein the scanner comprises a film drive chassis 30 with a film path 38 having an elongate first scanning aperture 83a coincident with image frames on the film and a second scan aperture 83b/83c coincident with an edge region of the film, the illuminant head assembly further comprising the planar light conducting channel 214a having a length substantially coincident with the length of the first scanning aperture, and having a second light conducting channel 214b/214c adapted to be in alignment with the second scan aperture.

3. The illuminant head assembly of claim 1, wherein the scanner comprises a film drive chassis 30 with a film path 38 having an elongate first scanning aperture 83a coincident with image frames on the film and first and second scan apertures 83b, 83c coincident with opposite edge regions of the film, the illuminant head assembly further comprising the main body having a length substantially coincident with the length of the first scanning aperture 83a, and having first and second light conducting channels 214b, 214c adapted to be in alignment with the first and second scan apertures 83b, 83c, respectively.

4. The illuminant head assembly of claim 1, wherein the diffusion material consists of barium sulfate.

5. The illuminant head assembly of claim 4 wherein the light pipe has a barium sulfate loading of within a range of 0.1%-1.0% by weight and the barium sulfate has a particle size in the range of 5-20 microns.

6. The illuminant head assembly of claim 5 wherein the barium sulfate loading is 0.25% by weight.

7. The illuminant head assembly of claim 1 wherein the linear light source includes a linear array of spectrally distinct LED light sources extending at least across the elongate light conducting channel.

8. The illuminant head assembly of claim 1, the scanner having a scan gate and a pair of support arms 120 on opposite sides of the scan gate, at least one of the support arms having a notch 134 formed therein; the head assembly further characterized by:

   the main body having opposite side portions 215 adapted to mate with the support arms and at least one of the side portions having a spring finger 218 positioned to mate and lock into the notch when the illuminant assembly is mounted into position on the support arms.

9. The illuminant head assembly of claim 8 wherein the film scanner support arms have elongated channels 132 formed therein and the main body side portions 215 are shaped to mate with the channels, the side portions including a plurality of crush ribs 216 positioned to engage edges 132a of the channels to hold the main body rigidly within and aligned to the channels when the head assembly is mounted on the support arms.

10. The illuminant head assembly of claim 8 wherein the linear light source comprises a substrate 206 and a line of spectrally distinct light sources 206a, 206b, 206c mounted on the substrate, the substrate having a plurality of apertures therein;

    the main body includes a plurality of support pads 232-234 providing reference datum support surfaces for the light source substrate, a substrate retention hook 222 adjacent one of the support pads 232, a further pair of the support pads 233, 234 having reference datum

locating posts 226, 227 extending from the reference datum support surfaces thereof in alignment with a corresponding pair of the apertures in the substrate, and at least one further locking hook 224 adapted to engage the substrate when mounted on the reference datum support surface thereby to hold the substrate rigidly in position on the main body with the linear light source in alignment with the elongated light channel.

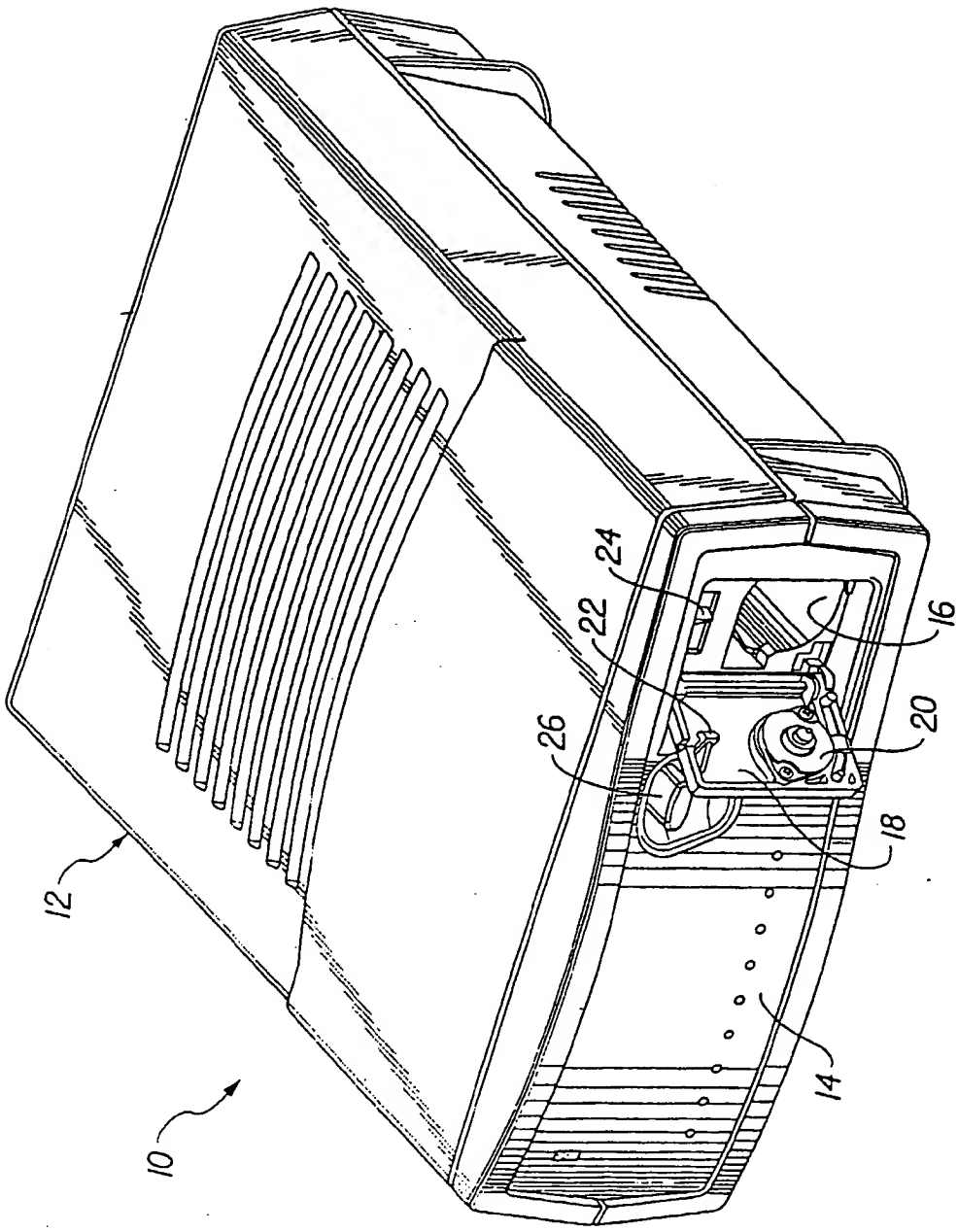

FIG. 1

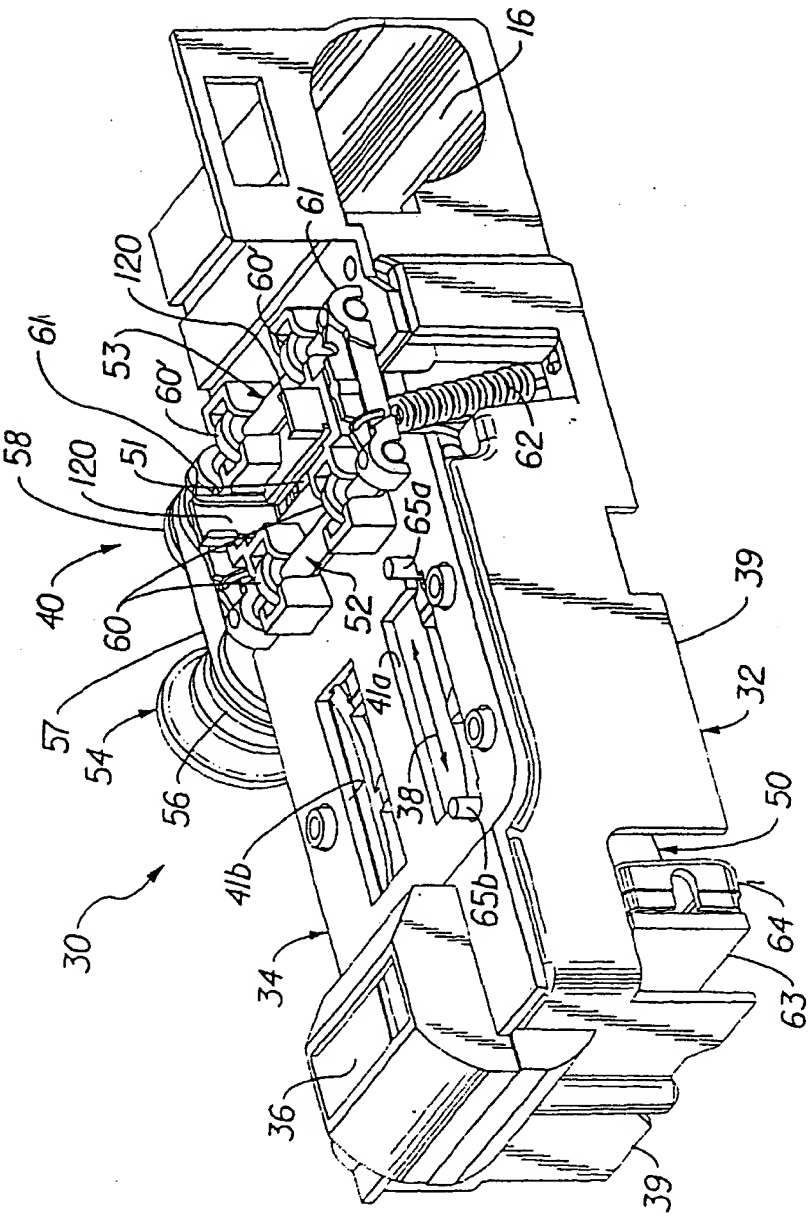

FIG. 2

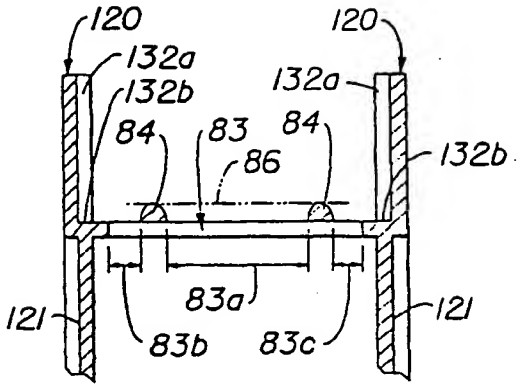

FIG. 3a

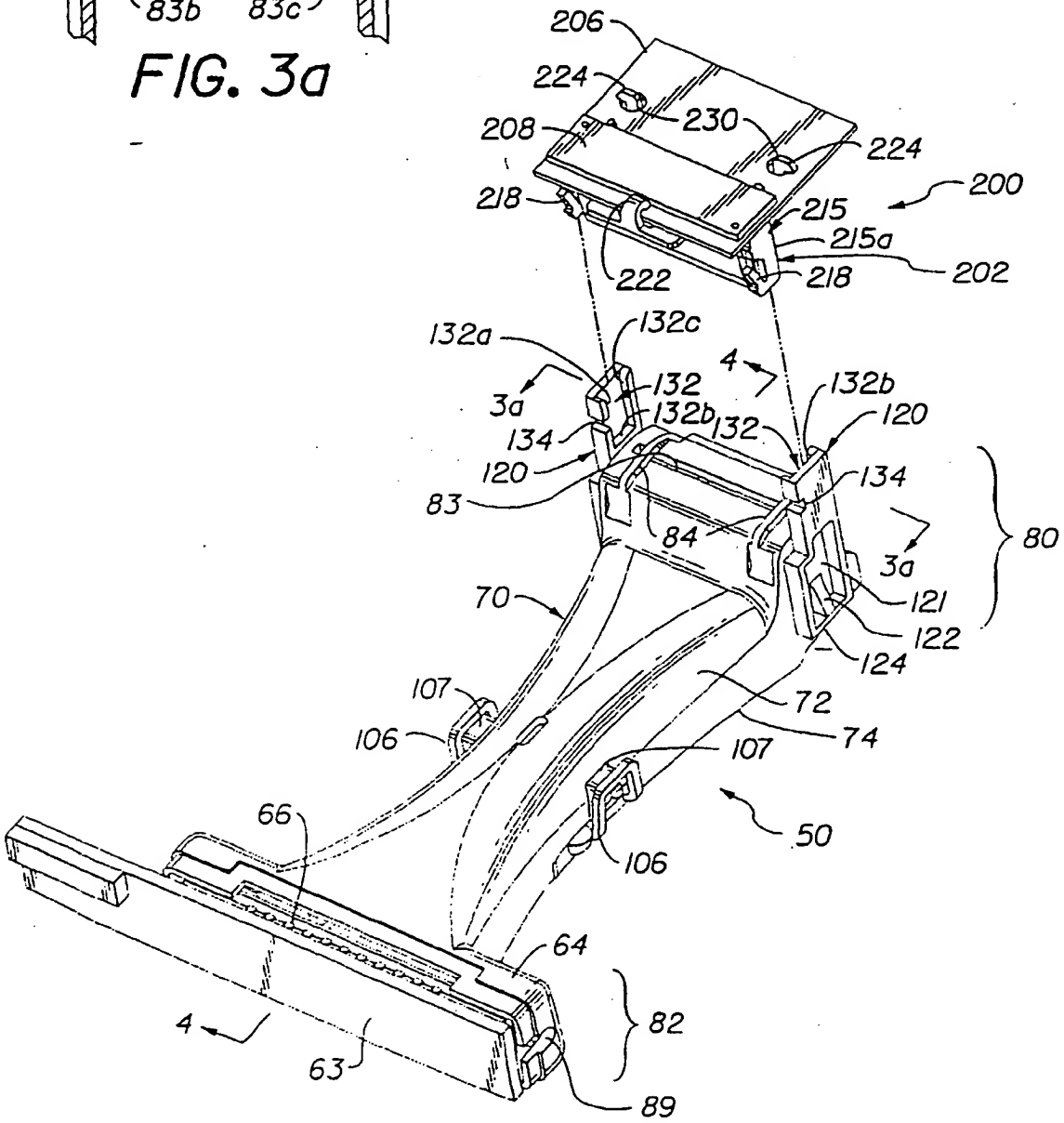

FIG. 3

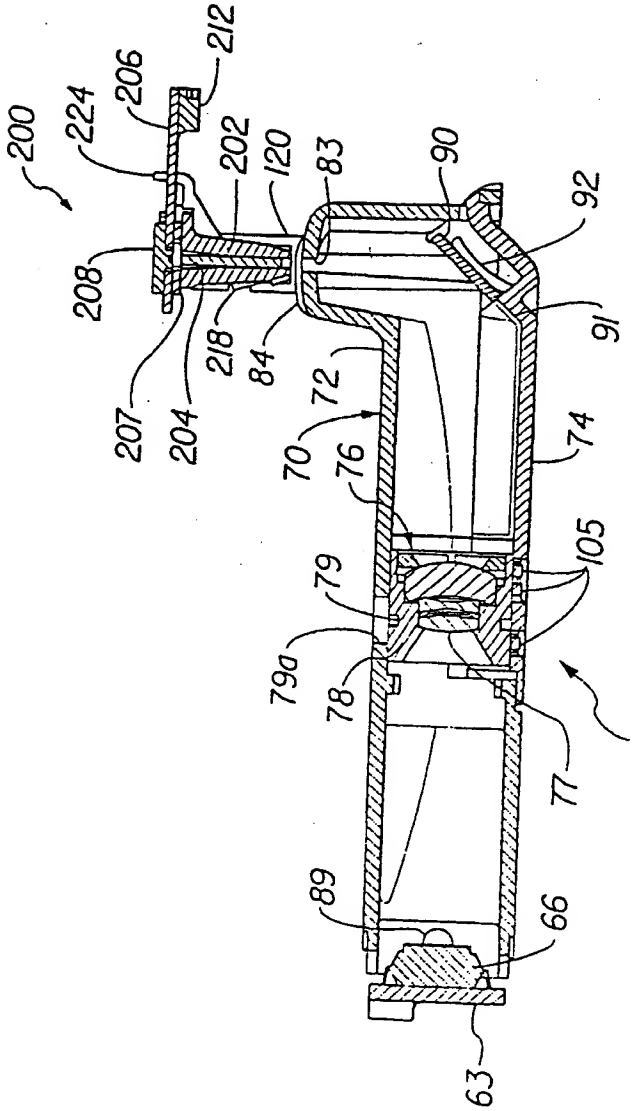

FIG. 4

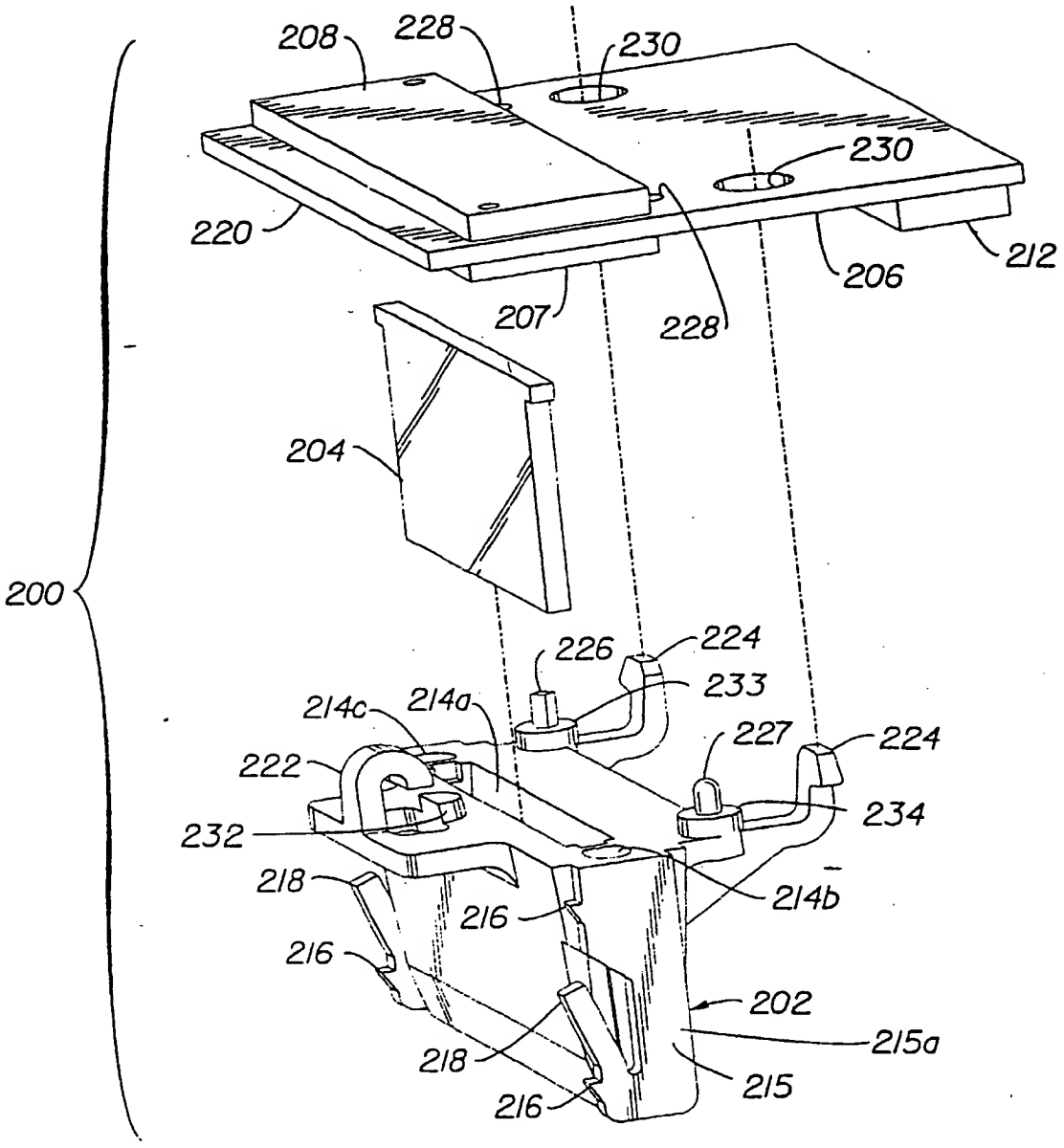

FIG. 5

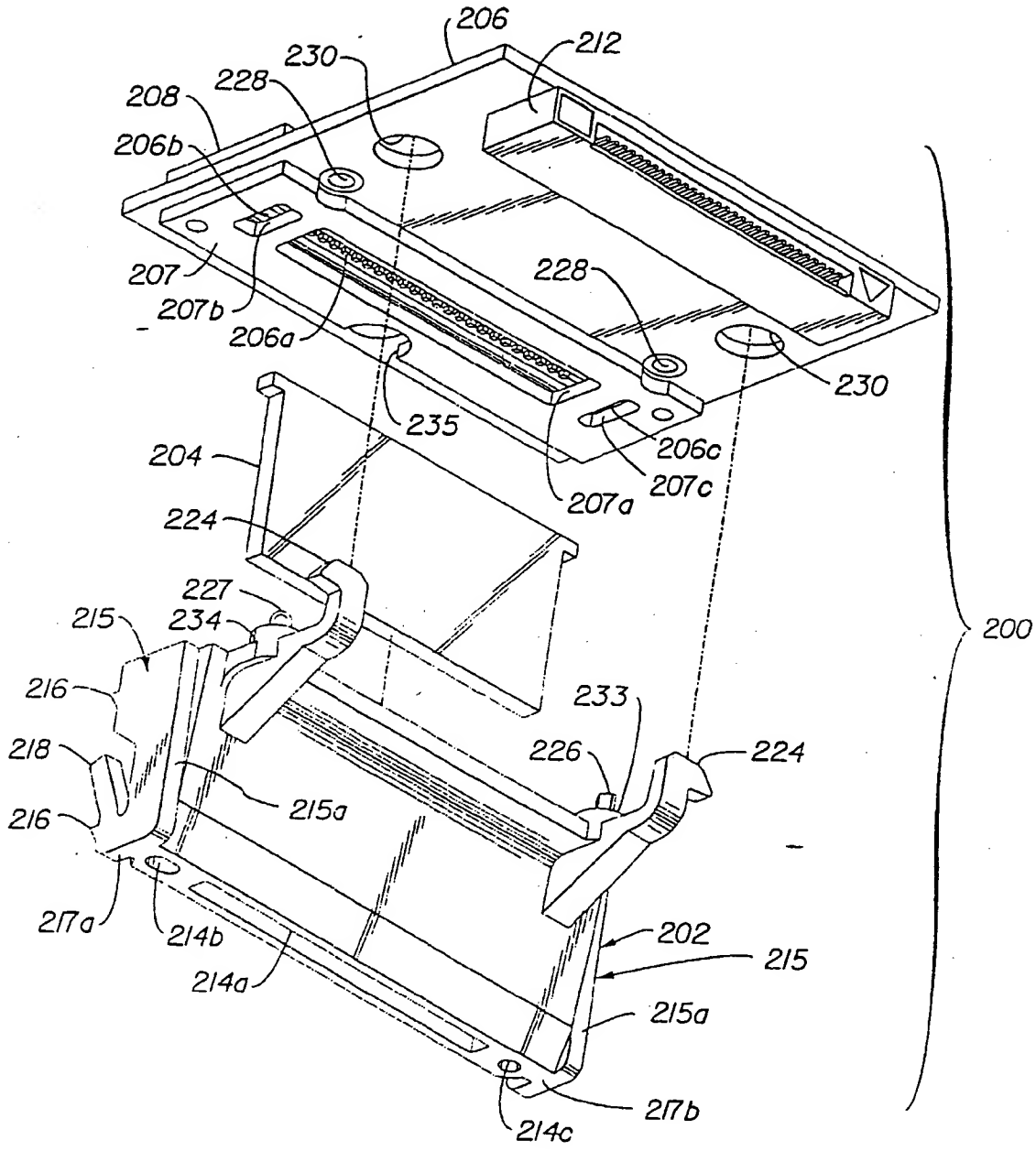

FIG. 6